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Observations on the genus *Neoseiulus* Hughes (Parasitiformes, Phytoseiidae). Redefinition. Composition. Geography. Description of two new species

by

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With 41 figures

ABSTRACT

This paper is a contribution to the division of amblyseiines into natural genera, as well as an attempt to revise the genus *Neoseiulus*. The studied material is coming from different geographical regions, two new species (*Neoseiulus aleurites* n. sp. and *N. erugatus* n. sp.) are described.

CONTENTS

1 — Introduction 658
2 — Material and techniques 659
3 — Genus *Neoseiulus* Hughes, 1948 660
    3.1 — Nature of the type species 660
    3.2 — Redefinitions 660
        3.2.1 — Preceding ones 660
        3.2.2 — Present one. 661
    3.3 — Main intrageneric variations 664

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4 — Composition 664
4.1 — *Marinellus* species group 665
4.1.1 — Key to females 665
4.1.2 — Synopsis of species 665
4.2 — *Barkeri* species group 668
4.2.1 — Key to females 668
4.2.2 — Synopsis of species 668
4.3 — Incertae sedis *Neoseiulus* members 673
5 — Discussion 674
Collection records 674
Terminological Index 675
Résumé 675
Species Index 676
References 676

1 — INTRODUCTION

The tribe Amblyseiini Muma, 1961 is a stock of free living Phytoseiidae, characterised by three submarginal peltidial hairs (instead of four) anterior to sensillum id4. A lot of ennomic (ATHIAS-HENRIOT 1977*b*) species have been described and, for the most part, are included in the tribe in a disorderly way. There are but a few correctly defined genera and these can accommodate only a minority of members (for instance: *Amblyseialus* Muma, 1961 (p. 287); *Chelaseius* Muma and Denmark, 1968; *Cydnodromus* Muma, 1961 (cf. Athias-Henriot, 1977*b*); *Dictydionotus* Athias-Henriot, 1979 (= *Dictyonotus* Athias-Henriot, 1978*a*, praeocc.), ...), the remaining ones being still largely doomed to an entropic condition.

A natural genus can be defined as a supraspecific taxon justified by a semiology composed of a discriminating feature and an associated set of characters. This semiology is doubly constraining: *a)* no exceptions are allowed in order to include a given species in a given genus; *b)* the characters which compose it are homologous, not analogous (= convergent).

In gamasids, the discriminating feature varies according to the group. As an example, let us consider the biramous paraxial hairs on the pedipalpal genu in the tocospermal genus *Eugamasus* Berlese, 1892 (Parasitidae) (ATHIAS-HENRIOT 1978*b*), etc.

In ennomic amblyseiines, the structure of the female insemination apparatus is better suited than any other feature as a distinguishing criterion. This assertion rests on the following considerations:

a) Podospermy is primitive (compared to tocospermy) and thus very ancient.

b) In podospermal clones of gamasids (thelytoky), this apparatus remains unchanged, whatever the duration of its disuse.

c) In cases of podospermal lines highly altered by parasitic life, this apparatus, because of its constancy, makes it posible to demonstrate their ancestral kinship.

As a result of the paucity of described supraspecific taxa in amblyseiines (of the high entropic content...), the systematic ordering of natural lines is still unrealistic.

This paper is a contribution to the division of amblyseiines into natural genera, as well as an attempt to revise the genus *Neoseiulus*.

2 — MATERIAL AND TECHNIQUES

This monograph is based on examination of specimens of the following species,

Typhlodromus agrestis Karg, 1960 — Germany,
Neoseiulus barkeri Hughes, 1948 — England,
Typhlodromus brevispinus Kennett, 1958 — California,
T. chascomensis Sheals, 1962 — Argentina,
Cydnodromus ghanii Muma, 1967 — Pakistan,
Amblyseius huffakeri Schuster and Pritchard, 1963 — California,
A. loxus Schuster and Pritchard, 1963 — Ohio,
Cydnodromus marinellus Muma, 1962 — Florida,
Amblyseius masiaka Blommers and Chazeau, 1974 — Madagascar,
A. mckenziei Schuster and Pritchard, 1963 — California,
A. mycophilus Karg, 1970 — Germany, Brazil,
A. oahuensis Prasad, 1968 — Hawaii,
Cydnodromus planatus Muma, 1962 — Florida,
Amblyseius salish Chant and Hansell, 1971 — British Columbia,
Neoseiulus transversus Denmark and Muma, 1973 — Brazil,
Amblyseius usitatus v. d. Merwe, 1965 — South Africa,
Cydnodromus vagus Denmark, 1965 — Florida,

as well of adults originating from Chile, Canada, Israel, various parts of Europe and Africa, and Madagascar.

Concerning described and figured but non-available material, it will be mentioned, when necessary: *a)* its probability of belonging to *Neoseiulus*; *b)* to what extent a possible use could be made of existing iconography.

The difficulties faced during the present investigation are quite usual, so that it is useless to enumerate them; however, it is worth noting that a high ratio of original descriptions were justified with respect to one or a few non directly related species (i.e. belonging to a genus other than *Neoseiulus* or to a different species group within this genus). The most important extra-group justifications will be mentioned, as well as several errors in figure numbering, etc. Moreover, type specimens of at least four original descriptions have not been deposited in the museum or national collection indicated in the papers.

The apparent spanandry (cf. *N. brevispinus* (Kenn.) in SCHUSTER & PRITCHARD, 1963, and also probably *N. barkeri* Hughes according to our observations) presumably indicates thelytoky, so that it is sometimes difficult to take up position on the systematic status of various forms commonly called "species".

Observations were made with an interference contrast Nachet-300 microscope (Nomarski patent). The organotactic terminology is given elsewhere (ATHIAS-HENRIOT, 1975). The drawings are semi-symbolic (loc. cit); some of them are incomplete, principally in respect of the sigillar system, as a result of the poor condition of available specimens. The measurements are in micrometers.

The material not lent by institutions is deposited in the Natural History Museum of Geneva.

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3 — Genus **Neoseiulus** Hughes, 1948

Type species *Neoseiulus barkeri* Hughes, 1948.

3.1 — Nature of the type species.

This brief historical survey recalls the avatars of the genus. The original description (Hughes 1948) was illustrated by figures of an amblyseiine female and of a male with typhlodromine peltidial chaetotaxy. As the female was described before the male, according to Priority Rule, *Neoseiulus* is unambiguously an amblyseiine. However, during several years, *Neoseiulus* was used to accommodate typhlodromine members (Ehara 1964, 1966; etc.). In his revision of fam. Phytoseiidae, Wainstein (1962*a*) placed *Neoseiulus* among *Typhlodromini* Karg, 1961.

The violation of the rule was noted by Athias-Henriot (1961), confirmed by Hughes (1964, in litt. to De Leon), De Leon (1965) and Muma & Denmark (1968). Muma (1967) discussed the problem without taking position. In 1976, Hughes gives the following correction: "Male... The chaetotaxy of the dorsal shield is similar to that of the female...", which is illustrated (Fig. 391) and is an uncontroversial amblyseiine. We have examined a male of the sample collected by Barker in 1945 and used by Mrs. Hughes for the original description; we can confirm its amblyseiine nature.

The above mentioned confusion accounts for the uncertainty of the taxonomic status of *Lasioseius polonicus* Willmann, 1949 *(a, b)* (Chant 1959); it is a *Typhlodromus* species according to Willmann's illustration; this was later confirmed by this author who corrected *L. polonicus* into *Typhlodromus (Neoseius) tiliacolus* (Willmann, 1957 in litt.); the correction is handwritten and *Neoseius* is probably a *lapsus pro Neoseiulus.* The suggested synonymy with *Lasioseius marinus* Willmann, 1952 (Chant 1959), which is probably a *Neoseiulus* member, is thus excluded.

3.2 — Redefinitions.

3.2.1 — *Preceding ones.*

According to Muma & Denmark (1968), the diagnosis of *Neoseiulus* Hughes is as follows.

Eight lateral dorsal hairs. One dorsal scutum. Sternal scutum as long as, or longer than wide, with a straight or concave posterior margin. Opisthogastral shield elongate pentagonal to nearly quadrate and about equal to the epigynium in width. Main inguinal sigillum ovate or elongate. Peritrema extending forward beyond vertical hair. Calyx tubular, saccular or poculiform. Spermatostylus with foot or heel terminal. Movable jaw with zero to two denticules. Fixed jaw with four to six denticules. No macrosetae on legs I, II, III. Zero to three macrosetae on leg IV.

According to MUMA & DENMARK (1970), the fixed jaw bears 4 to 8 teeth; the opisthogastral scutum can be shield-shaped; stIV is nearly always present; the male of some members have the solenostoma of gd4 enlarged.

From the preceding diagnosis, it is evident that they concern with a plurigeneric taxon, as it appears from the mentioned variations of shape of opisthogastral shield, of inguinal sigillum, number of cheliceral teeth and, principally, shape of calyx. It is thus necessary to give a more precise diagnosis.

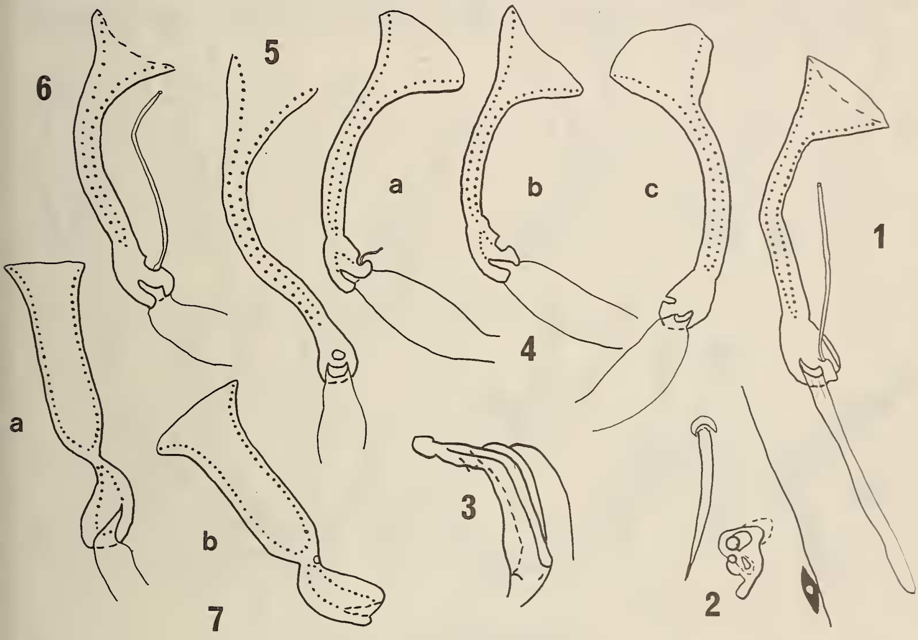

FIG. 1-7.

Neoseiulus spp.; 1, 4-7: ♀♀, insemination apparatus; 2, 3: ♂; 1, 2, 3: *N. loxus*; 2: right gland gd4, with s4 and id4; 3: spermatostylus; 4: *N. agrestis* (a, b: Germany, c: Canada); 5: *N. brevispinus*; 6: *N. marinellus*; 7a, b: *N. planatus*.

3.2.2 — *Present redefinition.*

— Insemination apparatus (Fig. 1, 4-12, 14, 16, 19, 23) — Adductor duct about as long as calyx, broad, soft. Accessus large, strongly indentated, thickwalled, not separated from trivium by a diameter modification. Trivium prominent, globular to oviform, as wide as or slightly wider or narrower than calyx base, fused to this base but never projecting on calyx bottom. Calyx basically tubular, from 2 to 6 times longer than its average diameter.

— Related characters — Dorsal adenotaxy bideficient (gd5, gd8 absent); gd2 weak (= metatactic). Isotrichy. On genu II, 7 hairs. Solenostoma of gd4 simple (female) or altered (male). Dorsal scutum (Fig. 37, 41) smooth or anterolaterally with a few ridgelets, sometimes slightly ornamented between Z1-J2-Z4-S5 (ridgelets or grooves). Dorsal hairs short, simple, rather thin; s4 equal to or somewhat longer than z4. Z4 longer than S2; gd1 posteroantiaxial to j3, equidistant from j3 and z3 or closer to the former. Segments j3-gd1-z3, ids-Z4-Z5, Z1-idl1-gd5 and s4-gd4-id4 nearly straight or obtuse-angled; idl1 anterior and hardly paraxial to Z1 or anteroparaxial to this hair; z3-id2-z4, gd2-z4-id2, idm1-J2-idm2 not very far from right angle; id2 much closer to z4 than to z3; gd6 equidistant from Z1 and id6 or much closer to the sensillum; idl1 equidistant from Z1 and gd6 or much closer to the gland; idm1 antiaxial to J2 and anterior or posterior to the level of the hair. Peritrema entire. Sternogenital sclerocuticle smooth, with few lateral ridgelets on the sternal scutum. This shield almost as long as wide; its posterior margin weakly concave between the slightly prominent lobes on which v3 and v′3 are inserted. Front tip of endopodal IV cochleariform (Fig. 18, 20, 22). Epigynium (Fig. 24, 33) with hind margin shorter than width of opisthogastral shield, enlarged posterior to v5 where the margins are straight or somewhat convex; these are connected with hind margin in a sharp or slightly rounded angle. Large inguinal sigillum elongate, narrow, cuneiform, neither egg- nor regularly spindle-shaped (Fig. 24). Genital sigilla of 4th and 5th pairs thin, linear, hardly individualized. Genital sigillum of 6th pair (= sgpa)

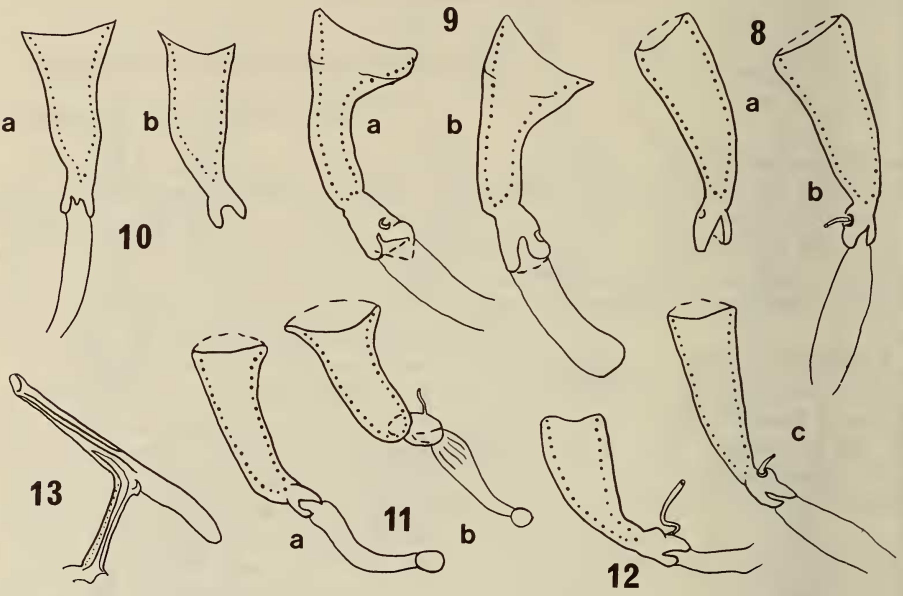

FIG. 8-13.

Neoseiulus spp.; 8-12: ♀♀, insemination apparatus; 13: ♂; 8: *N. barkeri* (a: paratype, b, c: Germany); 9a, b: *N. huffakeri*; 10a, b: *N. transversus*; 11a, b: *N. chascomensis*; 12: *N. usitatus*; 13: idem, spermatostylus.

mostly located on opisthogastral shield (Fig. 28), frequently projecting marginally (Fig. 27*a*). or, less often, tylochore (Fig. 34). The hoplochorous condition of sgpa is more primitive than the tylochorous one found in numerous amblyseiine genera. As the above mentioned variation is of vertitional nature, the front third of the opisthogastral shield exhibits either an asymmetrical or a subsymmetrical pattern. This shield at least as long as wide, with transverse striae and lateral margin straight or slightly concave; paranal sigilla submarginal. The solenostoma of gv3 is either punctiform, removed from preanal sigillum and posteroparaxial to V3 (primitive condition) or crescentic, close to preanal sigillum and about paraxial to V3 (evoluted condition). On basitarsus IV, stIV usually, though not always, elongated. Chelicera paucidentated: movable jaw unidentated, sometimes unilaterally bidentate (vertition); fixed jaw with two to four teeth.

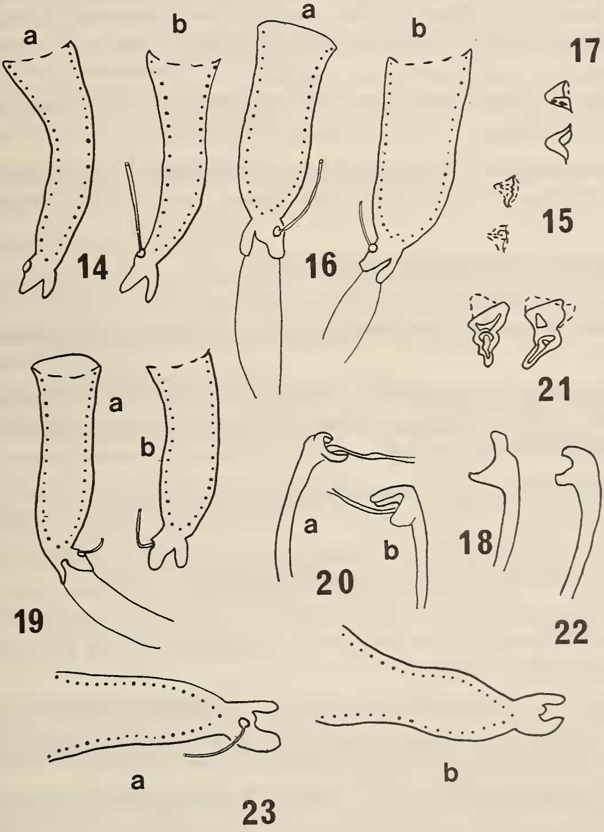

FIG. 14-23.

Neoseiulus spp.; 14, 16, 19, 23: ♀♀, insemination apparatus; 15, 17, 21: ♂♂, solenostoma of dorsal gland gd4; 18, 20, 22: ♀♀, endopolad sclerit IV (20 with cuticular funicle fixed near coxal base); 14a, b, 15: *N. masiaka*; 16a, b: *N. ghanii*; 17, 18: *N. barkeri*, paratypes; 19a, b, 20a, b: *N. erugatus*; 21, 22: *N. usitatus*; 23a, b: *N. aleurites*.

— Male — Opisthogastral shield subtriangular. Cingulum present; 5-6 V hairs, of which 4-5 hoplochorous. So far as known, spermatostylus L-shaped when gv3 is punctiform and gallow-shaped when gv3 is crescentic. The solenostoma of gd4 is variously modified; in available males, it can be greatly enlarged, covered by a tiny tectum, or doubled and more or less complicated.

— Chorology — *Neoseiulus* members live in various substrates such as plants, grasses, litter, organic materials, stored products... This fact and their subcosmopolitan distribution make a partly anthropochorous dispersion plausible.

3.3 — MAIN INTRAGENERIC VARIATIONS.

One has to distinguish between vertitions common to the whole genus and variations connected with evolutionary divergences.

Instances of the formers are, on the one hand, the desclerotising process of the antero-lateral part of the female opisthogastral shield, with various degrees of individualisation of sgpa and presence of notches (Fig. 26, 34 and cf. *N. stolidus*, Fig. 28, in Chaudhri, 1968) with a noticeable ratio of asymmetrical patterns, and, on the other hand, the unilateral bidentation of the female movable jaw.

The second set of variations affects fixed structures within different lines. The most important are the following.

a) Evolutionary condition of gv3 which can be estimated by the various locations of its opening with regard to the ridgelet cell situated posterior and close to V3 (Fig. 25, 28).

b) Shape of spermatostylus and its relation to *a)*.

c) Occurence of gland gd2 (Fig. 32, 41).

d) Ornamentation of the medio-antiaxial region of dorsal shield (absent, ridgelet- or groove-like).

f) Details of insemination apparatus. Shape and proportions of calyx (bell-, cone-, funnel-shaped...). With respect to the basal diameter of calyx, the atrium is equal to, narrower or wider than it.

Finally, variations in length of several hairs were noted.

4 — COMPOSITION

Several related species are not included in *Neoseiulus* as they do not agree with the present generic definition. These are:

— The orthoadenic species *Amblyseius vineaticus* Wainstein, 1978, *A. cinctutus* Livchits and Kuznetsov, 1972, *A. makuwa* Ehara, 1972, *A. arutunjani* Wainstein and Begliarov, 1971 and *A. vanderlindei* v. d. Merwe, 1965.

— *Typhlodromus marginatus* Wainstein, 1961 = *Amblyseius polyporus* Wainstein, 1962*b* in which gd8 seems to be present and there is a neck between atrium and calyx; it is also the case in *A. polyporous* Wainst. sensu KARG 1965.

— In *A. pegasus* Schuster, 1966, the dorsal shield is extensively ornamented, with thick hairs; among the seven hairs of genu II, one is peg-like.

— In *A. uliginosus* Karg, 1976, the opisthogastral shield is proportionately wider when compared with epigynium.

According to the above-mentioned characters (§§3.3, *a*, *b*), the genus *Neoseiulus* can be divided into two groups:

a) Gland gv3 primitive, punctiform; in the known males, spermatostylus L-shaped (Fig. 3, 26): *Marinellus* group.

b) Gland gv3 evoluted, crescentic; in the known males, spermatostylus gallow-shaped (Fig. 13, 34): *Barkeri* group.

4.1 — *Marinellus* SPECIES GROUP.

4.1.1 — *Key to females.*

A1 — Gland gd2 present [1] (Fig. 41) . . . . B

A2 — Gland gd2 absent C

B1 — An elongate hair on basitarsus IV. Calyx long, with proximal part cylindrical, thinner than atrium and distal part wide-mouthed; its wall thick. Embolus and spermatic duct conspicuus (Fig. 1). On dorsal shield, scarce anterolateral ornamentation (Fig. 38) . . . . *N. loxus*

B2 — No elongated hair on basitarsus IV. Dorsal shield with ridgelet-like ornamentation on its mediolateral region (Fig. 41) . . . . . . *N. marinellus*

C1 — Calyx bell-shaped, thick-walled. Length of atrium almost half that of calyx (Fig. 7) . . . . D

C2 — Insemination apparatus as in B1 . . . . E

D1 — Shape of thick atrium a truncated cone; embolus on its proximal part (Fig. 9). Gland gv3 primitive but still inside the (paired) cell formed by ridgelets at level of preanal sigillum. Mediolateral region of dorsal shield ornamented (Fig. 39) . . . . *N. huffakeri*

D2 — A strong constriction between calyx and atrium, on which the embolus is weakly visible (Fig. 7). Situation of gv3 especially primitive, posterior to the above-mentioned cell, and more posteroparaxial to V3 (Fig. 25) . *N. planatus*

E1 — Dorsal shield smooth, except few anterolateral ridgelets. Solenostomas of dorsal glands large (Fig. 36) . . . . *N. agrestis*

E2 — Dorsal shield with somewhat denser anterolateral ridgelets and with groove-shaped ornamentation on medio-antiaxial region (Fig. 40). Solenostomas of dorsal glands small. Calyx slightly longer and less enlarged distally (Fig. 5) . . . . *N. brevispinus*

4.1.2 — *Synopsis of species.*

— **Neoseiulus loxus** (Schuster and Pritchard, 1963) (Fig. 1, 2, 3, 38).

Amblyseius loxus Schuster and Pritchard, 1963 = *Cydnodromus vagus* Denmark, 1965 **syn. nov.**

The above synonymy is based on examination of type specimens. They are identical, except the hairs of *C. vagus* being slightly longer than in *N. loxus*; but such a variation

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[1] *N. setulus* (Fox) possesses gd2, but is not included in the key, for reasons exposed further on.

is common in *Neoseiulus* members and could be partly of seasonal origin (CHANT 1955), so it is not considered as a discriminant feature. Moreover, *C. vagus* was only justified with respect to *C. gracilis* Muma, 1962, which obviously does not belong to *Neoseiulus*.

Distribution — Type material from California, from matted layers of *Zostera marina* on sea shore. Also found in Florida, from plants, litter, grass (DENMARK 1965) and from litter and various plants (MUMA & DENMARK 1970).

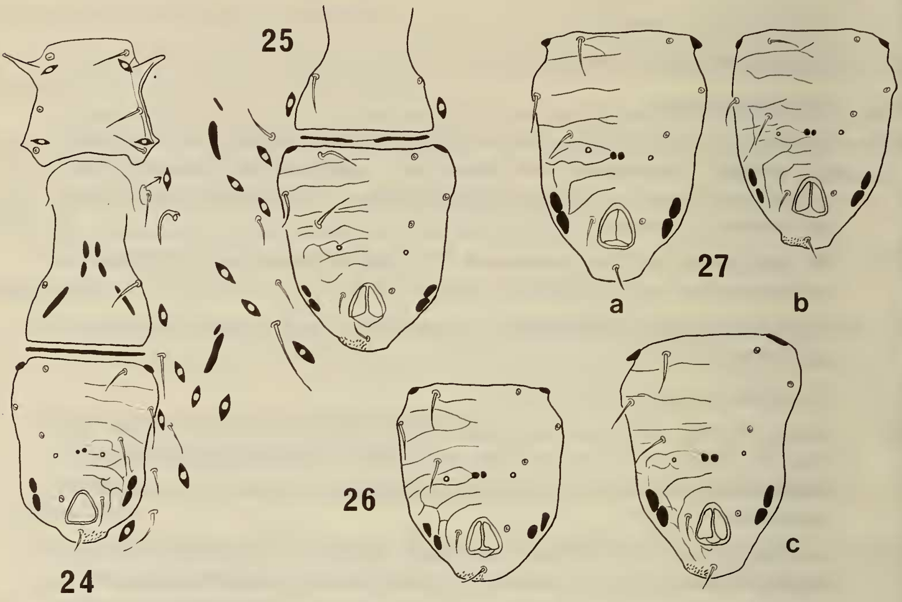


FIG. 24-27.

Neoseiulus spp., ♀♀; 24: *N. marinellus*, ventral surface; 25: *N. planatus*, opisthogastral region and posterior region of epigynium; 26: *N. brevispinus*, opisthogastral shield; 27: *N. agrestis*, idem (a: Canada, b: Germany, c: France).

— **Neoseiulus agrestis** (Karg, 1960) (Fig. 4, 27, 36).

Typhlodromus agrestis Karg, 1960 = *Amblyseius salish* Chant and Hansell, 1971 **syn. nov.**; ? = *Amblyseius harrowi* Collyer sensu Schicha, 1980 syn. pres.

Examination of type specimens shows that the only perceptible difference is the distance between V1 and V3, somewhat shorter in *N. salish*; this variation can be put down to account of the morphological instability of the anterior half of opisthogastral shield. Moreover, *A. salish* has not been justified in the original description.

Distribution — Type material collected in Berlin, from portato field. British Columbia, on plants, shrubs, bark (CHANT & HANSELL 1971). We have also examined specimens from France (F/76-III), Canada (CDN/20), Chile (RCH/130), from litters and soils.

— **Neoseiulus marinellus** (Muma, 1962) (Fig. 6, 24, 41).

Cydnodromus marinellus Muma, 1962, sed non p. 5, Fig. 9H: *N. planatus* (Muma, 1962).

Neoseiulus marinellus (Muma), MUMA & DENMARK 1970: Fig. 395, 396.

Distribution — Type material from litter in Florida. Common in litter and various plant substrates in Florida (Muma and Denmark, 1970).

— **Neoseiulus planatus** (Muma, 1962) (Fig. 7, 25).

Cydnodromus planatus Muma, 1962, sed non p. 7, Fig. 10B: *N. marinellus* (Muma, 1962).

Neoseiulus planatus (Muma), MUMA & DENMARK 1970: Fig. 410 (p. 105).

Distribution — Type material from litter in Florida. Found in litter and on plants in Florida (MUMA & DENMARK 1970).

— **Neoseiulus brevispinus** (Kennett, 1958) (Fig. 5, 26, 40).

Typhlodromus brevispinus Kennett, 1958.

Distribution — Type material from strawberries, litter and low growing plants in California. Very common species in California according to SCHUSTER & PRITCHARD (1963).

— **Neoseiulus huffakeri** (Schuster and Pritchard, 1963) (Fig. 9, 39).

Amblyseius huffakeri Schuster and Pritchard, 1963.

According to Denmark (pers. comm.), *N. huffakeri* is synonymous of *N. setulus* (Fox); but in type material of *N. huffakeri*, gland gd2 is lacking, whilst it is present in *N. setulus* (cf. MUMA & JOHNSTON in litt.); moreover in the last species, the calyx is elongated, whereas it is short in *N. huffakeri*.

Distribution — Type material from litter, sod, in California.

— **Neoseiulus setulus** (Fox, 1947).

Borinquolaelaps setulus Fox, 1947.

N. setulus (Fox) is mentioned and illustrated by MUMA & JOHNSTON (in litt.) and, from this iconography, clearly belongs to *Neoseiulus*. Having checked Fox type material, the above mentioned authors state that *N. brevispinus* (Kennett, 1958) is a synonym of *N. setulus*; this does not agree with their drawing of *N. setulus* dorsal shield as it indicates that gland gd2 is present which is not the case in *N. brevispinus*. We did not have the possibility of checking Fox's type and as the original description is poor and MUMA & JOHNSTON give neither redescriptions nor measurements, *N. setulus* is not included in the key.

Distribution — Type material found on *Rattus norvegicus* in Puerto Rico. It is recorded by MUMA & JOHNSTON (in litt.) from Ohio, but we consider the specimens examined by them as incertae sedis species.

4.2 — *Barkeri* SPECIES GROUP.

4.2.1 — *Key to females.*

A1 — Gland gd2 present (Fig. 41) . . . . B

A2 — Gland gd2 absent (Fig. 35) C

B1 — Dorsal hairs short; z3 = 9; s4 does not reach gd4; stIV = 46. Anterior half of opisthogastral shield smooth. Calyx short, truncated-cone-shaped. Atrium narrow, about as wide as proximal part of calyx (Fig. 11) *N. chascomensis*

B2 — Dorsal hairs longer; z3 = 16; s4 terminates beyond gd4; stIV = 58. Anterior half of opisthogastral shield with striae. Calyx more or less campaniform (Fig. 10) . . . . *N. transversus*

C1 — Calyx truncated-cone-shaped, slightly curved. Atrium wide as or slightly wider than proximal part of calyx, prominent at level of embolus (Fig. 14); stIV = 55-60. In male, gd4 solenostoma hypertrophied, covered by a tiny tectum (Fig. 15) . . . . *N. masiaka*

C2 — Calyx slightly more cylindrical, shorter and wider, not curved (Fig. 19); stIV = 48-50. Dorsal shield narrower. Male unknown . . . . . . *N. erugatus*

C3 — Calyx distinctly conical (Fig. 12); stIV = 58-63. In male, gd4 solenostoma hypertrophied, twofold (according to a specimen identified by F. W. Schultz in 1974) (Fig. 21) . . . . *N. usitatus*

C4 — Hair stIV at least 63 (63-68) . . . . D

D1 — Calyx truncated-cone-shaped, with one side straight and the other curved (Fig. 8). Atrium narrow, about as wide as calyx base . . . . *N. barkeri*

D2 — Calyx subcylindrical, wider. Atrium narrower than calyx base (Fig. 16). Posterior to v5, margin of epigynium rounded (Fig. 31) . . . . . . *N. ghanii*

D3 — Calyx campaniform (Fig. 23), longer. Posterior to v5, margin of epigynium straighter, with a sharp conjunction with the hind one (Fig. 28). Male unknown . . . . *N. aleurites*

4.2.2-*Synopsis of species.*

— **Neoseiulus barkeri** Hughes, 1948 (Fig. 8, 17, 18, 29, 30, 37).
= *Amblyseius mckenziei* Schuster and Pritchard, 1963, **syn. nov.**
= *A. oahuensis* Prasad, 1968, **syn. nov.**
= *A. picketti* Specht, 1968, **syn. nov.**
= *A. mycophilus* Karg, 1970 (synonymised to *A. mckenziei* by Karg ? in litt).
?= *A. cydnodactylon* Shehata and Zaher, 1969, syn. pres.
?= *A. sugonjaevi* Wainstein and Abbasova, 1974, syn. pres.

Calyx regularly enlarged proximodistally, with one side straight and the other one slightly convex; its base narrower than atrium. Atrium somewhat asymmetrical, with embolus not far from calyx base. In male, solenostoma of gd4 unique, hypertrophied, covered by a tiny tectum.

From comparison of available type materials, the above synonymic list was established. The type material of *A. mycophilus* we received was labelled "*A. mckenziei*", as far as we are aware, this synonymy has not been previously published. It is worthwhile to mention that this species was intercepted in Germany (quarantine) coming with cacao from Brazil. The iconography of *A. picketti* enables us to synonymise it with *N. barkeri*. It is not the case for *A. sugonjaevi* and *A. cydnodactylon* which are thus considered as presumed synonyms.

Original descriptions of *A. oahuensis*, *A. mycophilus*, *A. picketti* and *A. sugonjaevi* were only justified in respect to species not belonging to *Neoseiulus ; A. cydnodactylon* is not justified at all.

It should be mentioned that some differences in hair length are noted; but such variations are common in the genus. For instance, in female *barkeri*-paratypes, stIV = 63-73 and Z5 = 48-58; in one specimen, Z5 was abnormally longer than Z'5 (? vertition).

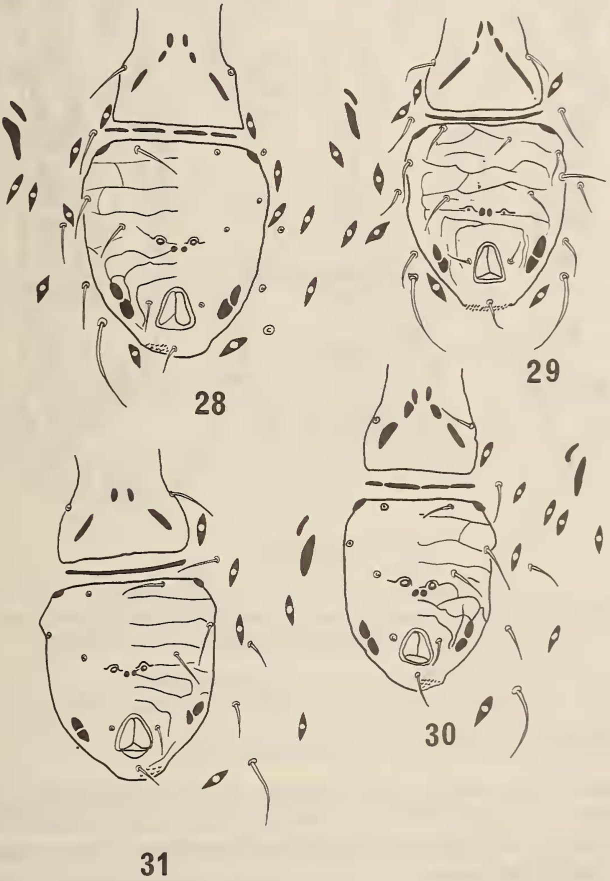


FIG. 28-31.

Neoseiulus spp., ♀♀, posterior part of epigynium and opisthogastral region; 28: *N. aleurites*; 29, 30: *N. barkeri* (29: Germany, 30: paratype); 31: *N. ghanii.*

Distribution-Type material from germinating barley plumules in London docks. Also recorded from California by Schuster & Pritchard (1963), Hawaii (bean leaves, chicken manure, sparrow nest) by Prasad (1968), New Jersey (plants and shrubs in greenhouse) by Specht (1968), Berlin (mushrooms in greenhouse) by Karg (1970), ? Egypt (grass with soil) by Shehata & Zaher (1969), Azerbaijan (bird nest) by Wainstein & Abbasova (1974). We have examined specimens from Algeria (L/169, L/615, L/B332), N. Italy (sp 305c), N. Spain (sp 472), Guinea (L/ A587).

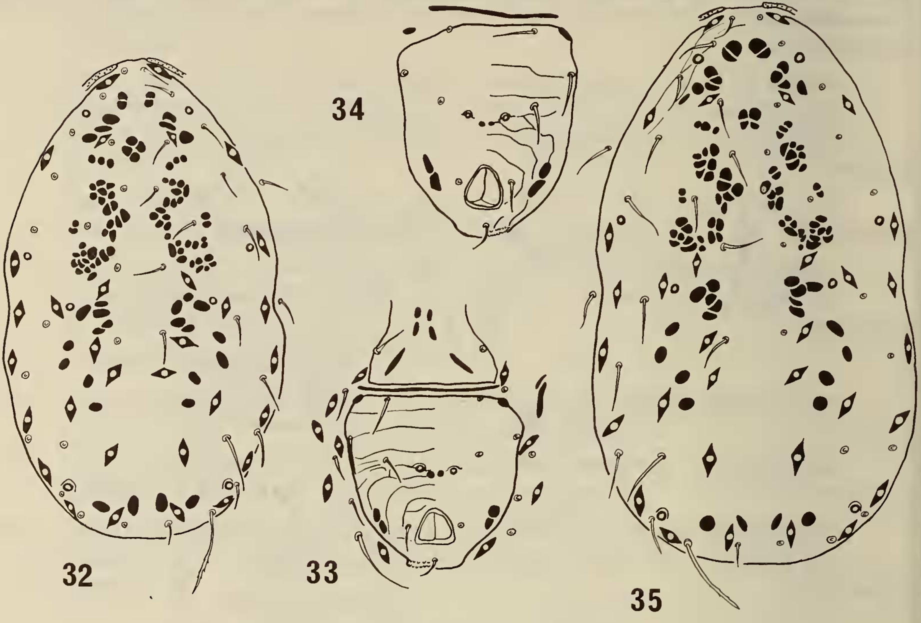


Fig. 32-35.

Neoseiulus spp., ♀♀; 32, 35: dorsal surface;
32: *N. erugatus*; 33: idem, posterior part of epigynium and opisthogastral region;
34: *N. masiaka*, opisthogastral shield; 35: *N. aleurites*.

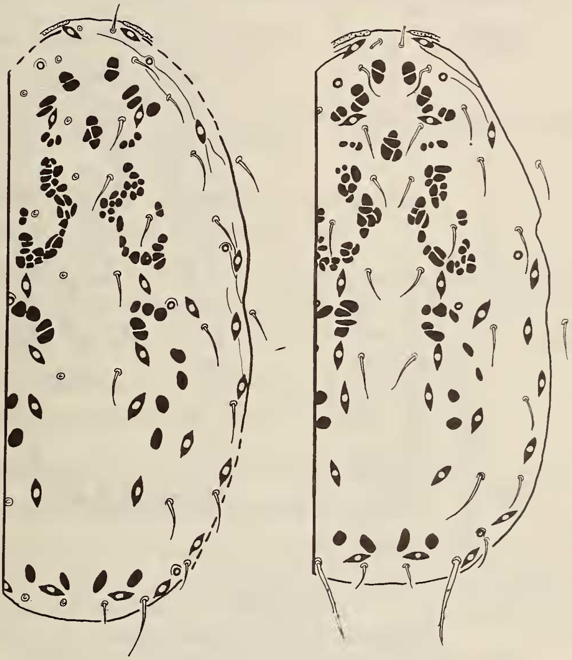
— **Neoseiulus aleurites** n. sp., female (Fig. 23, 28, 35).

Dorsal shield with only a few ridgelets on its anterolateral region. Ratios j3/j4, s4/Z1, Z1/S2 = 1; Z5/Z4 = 1,4; J2 reaches idm2; S4 not passing id15;Z4 slightly passing gd9; Z5 with a few tiny spinules. Dorsal glandular solenostomas, except that of gd9, rather small; gd2 absent. Apex of peritrema at level of j1. Posterior to v5, epigynial margins divergent and straight, making a sharp conjunction with hind margin. Opisthogastral shield subpentagonal, slightly attenuated posteriorly. Calyx campaniform, from 2,6 to 3,4 times longer than wide, about 3,8 times longer than atrium, with straight axis. Z5 = 55; Z4 = 39-40; stIV = 72-73; tIV = 111.

Male unknown.

Holotype-A female (n° F314)-litter under *Schinus molle*-27.12.1961-Beit-Dagan, Israel (S. Amitai coll., E. Swirski leg.).

Justification-*N. aleurites* is similar to *N. ghanii* (Muma), but differs from it by the calyx being somewhat more enlarged distally (instead of more cylindrical), proportionately more elongated (length/width = 2,6-3,4 instead of 2,3-2,9), by straight epigynial margins posterior to v5 (instead of convex) and by slightly longer tIV (111 instead of 106-108) and Z4 (it does not reach gd9 in *ghanii*).



36 37

FIG. 36, 37.

Neoseiulus spp., ♀♀, dorsal shield;
36: *N. agrestis* (Canada); 37: *N. barkeri* (Algeria).

— **Neoseiulus erugatus** n. sp. (Fig. 19, 20, 32, 33), female.

Comparatively small species (tIV = 94-98). Dorsal shield 1,8 times as long as wide, smooth. Z4 reaching slightly beyond gd9; J2 not reaching idm2; ratio Z5/Z4 about 1,5; S2 reaches id14. Dorsal glandular solenostomas, except that of gd9, rather small; gd2 absent. Apex of peritrema near the base of j1. Posterior to v5, epigynial margins divergent, asymmetrically convex in the holotype. Opisthogastral shield wide, hardly attenuated posteriorly. Calyx about 3 times longer than wide, campaniform but with little variable diameter, about 5,5 times longer than atrium. Atrium projecting laterally at level of embolus. Z5 = 53-55; Z4 = 34-36; stIV = 48-56.

Male unknown.

Holotype-A female (n° 1655)-Ivory Coast: CIB/3087.

Justification-*N. erugatus* is similar to *N. ghanii* (Muma) and *N. masiaka* (Bl. & Ch.), but smaller (tIV = 94-98, instead of 106-108 and 98-113 resp.) and with shorter stIV (48-56 instead of 70 and 55-60 resp.). It differs from the former by Z4 being longer, calyx more elongated, slightly narrowed at mid-length and somewhat more enlarged distally, and from *N. masiaka* by the calyx more cylindrical (instead of regularly enlarged), not or hardly curved (instead of more or less strongly curved).

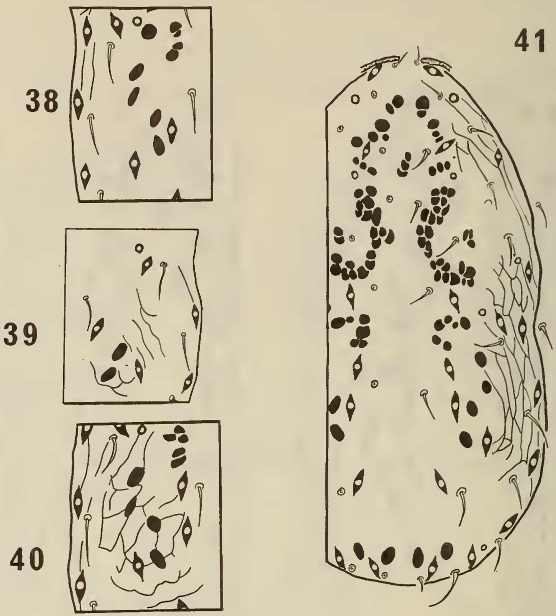


FIG. 38-41.

Neoseiulus spp., ♀♀, dorsal shield;
38-40: mediolateral region (the gland in top is gd6);
38: *N. loxus*; 39: *N. huffakeri*; 40: *N. brevispinus*; 41: *N. marinellus*.

— **Neoseiulus ghanii** (Muma, 1967) (Fig. 16, 31).

Cydnodromus ghanii Muma, 1967.

? = *Amblyseius venustus* Chaudhri, 1968, syn. pres.

It should be noted that the presumed synonym *A. venustus* Chaudhri originates from Pakistan, as does *N. ghanii* and that its original description is justified by comparison to non *Neoseiulus* species.

Distribution-Type material from *Gossypium* in Pakistan. In the same country, it is presumably recorded by CHAUDHRI (1968).

— **Neoseiulus stolidus** (Chaudhri, 1968).
Amblyseius stolidus Chaudhri, 1968.

This species is similar to *N. masiaka* (Bl. & Ch.), except the position of gv3 which lies paraxial to V3. To draw a final conclusion, it is necessary to check the type material (which is not deposited, as stated by Chaudhri, in the BMNH and USNM); for this reason, the species is not listed in the key.

Distribution-Type material from low growing plant in Pakistan.

— **Neoseiulus chascomensis** (Sheals, 1962) (Fig. 11).
Typhlodromus chascomensis Sheals, 1962.

Type material from littoral *Chascomus* shore laisse in Prov. Buenos Aires, Argentina. SCHICHA (1981) records it also from Australia.

— **Neoseiulus calorai** (Corpuz and Rimando, 1966).
Amblyseius calorai Corpuz and Rimando, 1966.

The available iconography does not make it possible to compare this species with other members of the *Barkeri* group and to include it in the key.

Distribution-Type material from low growing plants in the Philippines.

— **Neoseiulus transversus** Denmark and Muma, 1973 (Fig. 10).
Distribution-Type material from shrubs in Brazil.

— **Neoseiulus masiaka** (Blommers and Chazeau, 1974) (Fig. 14, 15, 34).
Amblyseius masiaka Blommers and Chazeau, 1974.

In the male, gd4 solenostoma unique, hypertrophied, covered by a tiny tectum.

Distribution-Type material from a mass breeding of *Tetranychus neocaledonicus* André originating from *Gossypium* in Madagascar. We have examined specimens from Madagascar (RM/16) and Ivory Coast (Cib/683, Cib/1538).

— **Neoseiulus usitatus** (van der Merwe, 1965) (Fig. 12, 13, 21, 22).
Amblyseius usitatus van der Merwe, 1965.

The male was found by F. W. Schultz in 1974 (seems unpublished) and possesses a doubled complicated gd4 solenostoma with a posterior small smooth taenidia.

Distribution-Type material from grass and plant in South Africa. We have examined specimens from South Africa, Algeria (L/102) and Ivory Coast (CI/2, CI/27).

4.3 — *Neoseiulus* SPECIES INCERTAE SEDIS.

Several presumed *Neoseiulus* members, owing to inadequate iconography, cannot be placed within or near any preceding species: *Amblyseius rangatensis* Gupta, 1977, *A. cynodonae* Gupta, 1977, *Typhlodromus indicus* Narayanan and Kaur, 1960 (India), *T. cucumeris* (Oudemans, 1929) sensu Westerboer and Bernhard, 1963, *Lasioseius marinus* Willmann, 1952 (Germany), *T. mungeri* McGregor, 1954 (California) and *Amblyseius monomacroseta* Tseng, 1976 (Taiwan).

5 — DISCUSSION

Generally speaking and particularly in gamasid studies, a method of observation which takes into account the nature of components of organisms and their evolutionary behaviour makes possible a rational comparison between natural lines. It facilitates morphological interpretation (identification of homologies and of evolutionary patterns) and the expression of semiologies bound up with natural groups (genera, etc.).

The method requires, in addition to a conceptual substrate, strictness of microscopical observation and of semantic practice.

The balance-sheet of this is an increased efficiency in morphological and systematic understanding of material studied and the method allows one to state the problems in a way cleansed of irrelevancies.

We shall end with some more concrete remarks.

Until now, generally, two specimens with similar insemination apparatus have been considered to be synonymous. This is not necessarily the case. In fact, with the above statement of what a natural amblyseiine genus is, it must be admitted that species with similar insemination apparatus can be different and differenciated by a set of details (little variations in organotaxy, in shape of calyx, etc.).

According to the above generic concept, it appears that, in amblyseiines, similar chaetotactic patterns could have emerged independently (they are not homologous traits).

Appropriate definitions of the various natural phytoseiid genera are important because they are the point of departure of progress in systematic studies. A further step would be the reevaluation of described species, particulary of those inadequately described and wrongly, or not at all justified.

COLLECTION RECORDS

CDN/20 — Litter in Window wells, Deep River, Ontario (Canada) — 03.06.1968 — (V. G. Marshall coll. & leg.).

CI and CIB — Côte-d'Ivoire. Station d'Ecologie Tropicale de Lamto, 150 km au nord de la côte atlantique au niveau de Grand Lahou, à la pointe du « V Baoulé », secteur de savanes jouxtant la forêt ombrophile.

CI/2 — Savane non brûlée à *Hypparrhenia* sur sol ferrugineux, sableux en surface: 30-45 cm — 25.09.1963 (A. Bessard coll.).

CI/127 — Savane brûlée sur sol ferrugineux: 30-45 cm — 24.12.1963 — (idem).

CIB/683 — Savane non brûlée à *Andropogon* et *Hypparrhenia.* Sol ferrugineux tropical: 7,5-10 cm — 02.02.1970 (F. Athias coll.).

CIB/1538 — Comme CIB/683 — 22.05.1970 — (idem).

CIB/3087 — Savane brûlée à *Hypparrhenia* et *Andropogon* sur sol ferrugineux tropical: 7,5-10 cm — 27.10.1970 — (idem).

F/76.III — Pré entre la route de Dijon (21-F) et le bâtiment principal de l'Abbaye de Citeaux, en plaine de Saône, environ 30 km au sud de Dijon — 12.03.1965 — motte (couverture et racines) dans le plein pré. (Prélèvement Station de Faune du Sol de l'I.N.R.A.).

L/102 — Zone est du marais de la Rassauta, Fort-de-l'Eau (DZ), environ 25 km à l'est d'Alger — 07.10.1956 — *Cynodon dactylon.*

L/169 — Sidi-Moussa (Plaine de la Mitidja, DZ), orangerie négligée — 02.11.1955 — *Plantago major.*

L/615 — Banlieue d'Alger (DZ), quartier « Bellevue » à El-Harrach — 14.10.1956 — *Phaseolus coccineus* dans un jardinet d'agrément.

L/B332 — Duzerville (Bône, DZ), champ de coton dans une plaine alluviale subcôtière de l'est du pays — 30.06.1959 — *Gossypium* sp.

L/A587 — Extraction de paille et de feuilles de bananier obtenues chez un épicier d'Alger, entourant un régime de bananes en provenance de Guinée — 15.05.1959 — feuilles mortes.

RCH/B 130 — Guatin (Antofagasta, Chile) — 21.08.1963 — Matorral higrôfilo (F. di Castri coll. & leg.).

RM/16 — Tananarive-Tsimbazaza (Madagascar) — 20.12.1964 — *Vitis vinifera* (J. Gutierrez coll. & leg.).

sp 305 c — Apuaner Alpen bei Stazzema (I), 750-1000 m — 08/10.09.1953 — Fallaub auf Kalk (H. Franz coll. & leg.).

sp 472 — Cabo Silleiro, près de Bayona (Prov. Pontevedra, E) — 01.08.1956 — extraction de gazon près de la côte (idem).

TERMINOLOGICAL INDEX

— Cingulum — Sclerocuticular remainder which unites peritremal and opisthogastral shields (Athias-Henriot 1977*a*).

— Ennomic (chaetotaxy) — A statistical, non systematic, concept. The chaetotaxy of *Amblyseius obtusus* (Koch, 1839), hair J2 being present or absent (Athias-Henriot 1977*b*).

— Semiology — Set of homologous features which are common to all members of a supra-generic taxon.

— Vertition — Individual variation of an idionymous organ, with reference to the most primitive condition known in the taxon, provided that its occurence is unilateral in a noticeable percentage of specimens and that it has an evolutionary significance. Though not directly hereditary, a vertition is variously repeated in the offspring. What is hereditary is the probability of existence of a vertition (cf. Hammen 1980 who gives Grandjean's references from 1939 to 1974).

— Weak (contr. strong) — The higher the probability of disappearance of an organ, the more this organ is weak (cf. Hammen 1980). Syn. metatactic.

RÉSUMÉ

Observations sur le genre *Neoseiulus* Hughes (Parasitiformes, Phytoseiidae). Redéfinition. Composition. Géographie. Description de deux espèces nouvelles. La tribu *Amblyseiini* est un ensemble de Phytoseiidae libres, basé sur la présence de trois (au lieu de quatre) poils peltidiaux submarginaux antérieurs à la sensille id4. De nombreuses espèces ennomiques ont été décrites et se côtoient en désordre dans la tribu *Amblyseiini*. La sémiologie d'un taxon naturel — par exemple, un genre — est un ensemble de caractères similaires par homologie (non par analogie ou convergence) dont l'un est discriminant du taxon. Chez les Gamasides, ce dernier peut-être situé en un point quelconque de l'organisme. Chez les Phytoseiidae, il est constitué par l'appareil d'insémination de la femelle. Le présent article est une modeste contribution au découpage en genres des *Amblyseiini*, ainsi qu'un essai de révision du genre *Neoseiulus*. Après la redéfinition de *Neoseiulus*, il donne les principales variations intragénériques, qu'elles soient de nature vertitionnelle ou systématique, des clés de détermination, une évaluation de la présente composition spécifique du genre, comportant en particulier la description de deux espèces nouvelles, ainsi que quelques mises au point morphologiques, synonymiques et géographiques.

SPECIES INDEX

agrestis : 659, 665, *666*
aleurites : 657, 668, *670*, 671
arutunjani : 664
barkeri : 659, 660, *668*, 669
brevispinus : 659, 665, *667*
calorai : *673*
chascomensis : 659, 668, *673*
cinctutus : 664
cucumeris : 673
cydnodactylon : 668, 669
cynodonae : 673
erugatus : 657, 668, *671*, 672
ghanii : 659, 668, 671, *672*
gracilis : 666
huffakeri : 659, 665, *667*
harrowi : 666
indicus : 673
loxus : 659, *665*
makuwa : 664
marginatus : 664
marinellus : 659, 665, *667*
marinus : 660, 673
masiaka : 659, 668, 672, *673*
mckenziei : 659, 668
monomacroseta : 673
mungeri : 673
mycophilus : 659, 668, 669
oahuensis : 659, 668, 669
pegasus : 664
picketti : 668, 669
planatus : 659, 665, *667*
polonicus : 660
polyporus : 664
rangatensis : 673
salish : 659, 666
setulus : 665, *667*
stolidus : 664, *673*
sugonjaevi : 668, 669
tiliacolus : 660
transversus : 659, 668, *673*
uliginosus : 664
usitatus : 659, 668, *673*
vagus : 659, 665, 666
vanderlindei : 664
venustus : 672
vineaticus : 664

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